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Optimizing Production Gas Wells By Using A Dual Completion

Hassi R'mel Field, Algeria

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Abstract

Dual completion was for a long time used to produce wells perforated on several zones. This type of completion concerns especially the oil wells , but few or not used on the gas wells.

In order to improve the production in the upper zone of gas wells, a study was carried out on production gas wells with 2 layers and 3 layers in Hassi-Rmel's field.

This field is located 500 km southward from Algiers in the Algerian Sahara and is one of the largest wet gas reservoirs in the world.

The gas-producing Hassi R'Mel field has three distinct reservoir horizons, zones A,B and C.

The zone A sandstones are composed of very fine grained sandstones which are locally clay-rich with anhydritic cementing in some places.

The zones B and C have very good reservoir quality with permeabilities to gas ranging from 300 to 1200 mD. Zone A also has very good reservoir quality for gas , however, it has lower permeability of generally less than 300 mD.

PLT recorded on these wells showed that the lower Zones B and C contribute to the majority of the gas production with the upper Zone A providing a lower contribution to the total production, in spite of an acidification of this layer.

The isolated zone C of some wells due to the water influx generated an increase in the flow of zone A.

This result pushes us to take in consideration the completion and to suggest to carry out a dual completion

for the producing wells with several zones in order to improve the production of the zone A which is obstructed by the good potential of the zone C.

This study will make it possible to show the necessity to use a dual completion on the producing gas wells with several layers, in order to improve the production of the upper zone and for avoiding having a cross-flow from this one towards the lower depleted zone.

The results carried us made it possible to make a technical and economic study which will enable to see the impacts on the reservoir, on the well's equipment and investment costs.

The purpose of this presentation is to show:

-the advantages and disadvantages from this completion on gas wells.

-the ratio of the profit on the capital costs after these completion.

Introduction

The producing gas wells with distinct reservoir horizons like Hassi R' Mel field presents problems of production.

these problems are due :

- water influx
- cross flow
- low flow from the higher zone

A study was undertaken to see the solution to be brought in order to improve the potential of these wells, with the use of the dual completion.

Several papers were written about using dual completion to improve producing wells who produce from several zones.[5-6-7] or to use new technique intelligent completion[1-2-3-4]

The goal of this study is to show the problems of these wells and the possibility and necessity to use one of these methods in order to improve potential of these wells who decreased due to the problems referred to above.

For this study we selected all producers whose production from zone A is lower than 200 000 m3 per day over 5 years period (2000-2005.)

The Hassi R'Mel field is located 500 km southward from Algiers in the Algerian Sahara. The field was discovered in 1956 and is one of the largest wet gas reservoirs in the world.

The 1st producing well was drilled in 1956, and meets a series of sandstone to the depth 2200 m and confirms the existence of a significant accumulation of gas with good petrophysic characteristics and a great extension. This well also highlighted the presence of 3 triassic sands designated (A - B - C). of Keuper age separated by thick shale layer and described as follow.

Layer A: the youngest, upper zone composed of very fine to fine sandstones which are locally argillaceous and contain argillaceous conglomerates. Very strong anhydritic cementing in some places.

Layer B: Fine sandstones with intercalated shaly beds distributed along North – South channels.

Layer C: Fine to medium sandstones, poorly cemented, characterised by quartizitic conglomerates.

Zones B and C have very good reservoir quality with permeabilities to gas ranging from 300 to 1200 Md. Zone A also has very good reservoir quality for gas, however, it has lower permeability of generally less than 300 Md.

PLT carried out on the wells showed that the zone B and C contribute in the majority of the production of gas compared to the zone A which takes part only few in spite of stimulation by acidizing .

In certain cases the good potential of the lower zones, obstructs the upper zone A . Several wells whose lower zone had been isolated, have showed an increase in flow in this zone A.

On certain wells cross-flow were observed from lower zone to upper zone.

On others, water influx were appeared in the lower zone.

Study

To face the problems encountered on these wells, and in order to improve the potential of these wells, a study was undertaken to see the best solution to be brought.

A simulation was carried out on these wells, to see which of the 2 methods, double completion or smart well completion will give good results.

For that, 3 wells were chosen among the list of the wells having problems.

well with cross-flow.

well with water influx.

well has low flow from the higher zone.

Well 1 (Water influx)

It is a producing gas well, which produces from two zones A and C. Several years of production, this well started to have water influx from the bottom lower zone. Currently this zone is isolated by bridge plug , and the well produces from the upper zone A.(fig 1)

A PLT realized on this well, has showed that this well has a water influx only with a certain flow rate . (tab 1)

Well 2 (cross-flow)

It is a producing gas well, which produces from two zones A and C . After one year of production, this well started to have water influx from the bottom lower zone. When this well was choked, to reduce water influx , a cross flow was appeared from the lower zone to upper zone (fig 2).

A PLT realized on this well, has showed that (fig 4 , fig 5, fig 6).

Well 3 (low flow from upper zone)

It is a producing gas well, which produces from 3 zones A,B and C. This well has low flow from the higher zone.(fig 3)

Solution 1

Using dual completion

Result s of simulation

Well 1 (Water influx)

On figure 7 are the result of correlation , with PLT results to see which correlation will can used for simulation. In this case we use Hagedorne&Brown.

On figure 8 and 9 we can see the results of well before shutting the lower zone C.

On figure 10 and 11 , are the results of the actual flow , for this well.

On figure 12 , 13 and 14 , are the results with using dual completion, for the upper zone A.

On figure 15 , 16 and 17 , are the results with using dual completion, for the lower zone C.

For zone A, we used the same head pressure than the well use currently to produce. We used 92 kg/cm2. We used a tubing 2"7/8.

For the Zone C, we choked this well, we used a head pressure 100 kg/cm2 in order to have a flow, without water influx as the PLT showed. We used a tubing 4"1/2.

This well currently produces 744 000 m3/d, coming from zone A.

The lower zone C has been isolated.

By using a dual completion, we can produce the lower zone C which it has been closed because a water influx, at a flow 751702 m3/d , with a tubing 4"1/2.

And produces the zone A at a flow 277 240 m3/d with a tubing 2"7/8.

Total production at surface is equal 1 028 942 m3/d. The gain of production is 284 942 m3/d with using dual completion .

Well 2 (cross-flow)

On figure 18 are the result of correlation , with PLT results to see which correlation will can used for simulation, In this case we use Hagedorne&Brown.

On figure 19 and 20 , are the results of the actual flow , for this well.

On figure 21 , 22 and 23 , are the results with using dual completion, for the upper zone A.

On figure 24 , 25 and 26 , are the results with using dual completion, for the lower zone C.

For the Zone A we used a head pressure 110 kg/cm2. We used a tubing 2"7/8.

For the Zone C, we choked this well, we used a head pressure 112 kg/cm2 in order to have the same flow as currently the well produces , without water influx . We used a tubing 4"1/2.

This well currently produces 620 352 m3/d, coming from zone C, minus 135 000m3/d who goes in zone A because a cross flow.

By using a dual completion, we can produce the lower zone C , at a flow 757 760 m3/d , with a tubing 4"1/2.

And produces the zone A at a flow 175 623 m3/d with a tubing 2"7/8.

Total production at surface is equal 933 383 m3/d. The gain of production is 313 031 m3/d with using dual completion .

Well 3 (low flow from upper zone)

On figure 28 are the result of correlation , with PLT results to see which correlation will can used for simulation, In this case we use Hagedorne&Brown.
On figure 29 and 30 , are the results of the actual flow , for this well.
On figure 31 , 32 and 33 , are the results with using dual completion for the upper zone A.

On figure 34 , 35 and 36 , are the results with using dual completion, for the lower zone C.

For the Zone AB, we used a tubing 2"7/8 with head pressure 100 kg/cm2 .

For the Zone C, we used a tubing 4"1/2 with head pressure 100 kg/cm2 .

This well currently produces 1 526 500 m3/d, of which 114 500 m3/d coming from zone A,

218 000 m3/d coming from zone B

and 1 194 000 m3/d coming from zone C.

By using a dual completion, we produce the lower zone C , at a flow 1 021 857 m3/d , with a tubing 4"1/2.

And produces the zone AB at a flow 327 924 m3/d with a tubing 2"7/8.

Total production at surface is equal 1 349 782 m3/d.

This result of production is less than production of well without using dual completion. For this category of wells this technique doesn't give solution, except using large diameter tubing .

Solution 2

Using smart well completion

Result s of simulation

Results of simulation (tab 2,3) , show that the intelligent completion, give the best results and more advantages compared with dual completion.

we do not have to change completion, and we can control the flow at the bottom by the intermediary of the valves which we can control from surface. (fig 38)

Gain

With dual completion, we can increase the production of:

well 1 with 284 942 m3/d and to produce zone C who was isolated because water influx. (fig 39)

Well 2 with 313 031 m3/d and to avoid a cross- flow. (fig 40)

Conclusion

The producing gas wells with distinct reservoir horizons presents problems of production. These problems are due :

- water influx
- cross flow
- low flow from the higher zone

The first technique used to solve these problems is to choke these wells, or to isolate completely the zone which have water influx. This technique generates a loss in gas production.

The use, of the dual completion or smart well completion , makes it possible to solve these problems and to improve the production.

These technical allow to:

avoid cross flow between zones;

optimise production from various zones thus increasing total flow rate;

reducing gas and/or water breakthrough.

Smart well completion, this new technical, give the best results and more advantages compared with dual completion.

we do not have to change completion, and we can control the flow at the bottom by the intermediary of the valves which we can control from surface.

For the producing wells , whose higher zone has a low flow, this technical does not give results, except using large diameter tubing.

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TABLES

Shut In — Flowing pressure at 2170 m = 2530,50 psia

Depths of interval (m)	interval length (m)	Zonal gross prod. m3/d	Zonal Free Gas Prod. m3/d	Zonal water prod. m3/d	Zonal Water cut (%)
2168,5-2169,5	1	4	**4**	0	0
2175,0-2179,0	4	-362	**-362**	0	0
2181,5-2184,0	2,5	-37	**-37**	0	0
2205,0-2214,5	9,5	405	405	0	0

IN Situ Rate 1 — Flowing pressure at 2170 m = 2503,80 psia

Depths of interval (m)	interval length (m)	Zonal gross prod. m3/d	Zonal Free Gas Prod. m3/d	Zonal water prod. m3/d	Zonal Water cut (%)
2168,5-2169,5	1	-55	**-55**	0	0
2175,0-2179,0	4	-334	**-334**	0	0
2181,5-2184,0	2,5	-228	**-228**	0	0
2205,0-2214,5	9,5	2920	2920	0	0

IN Situ Rate 2 — Flowing pressure at 2170 m = 2452,50 psia

Depths of interval (m)	interval length (m)	Zonal gross prod. m3/d	Zonal Free Gas Prod. m3/d	Zonal water prod. m3/d	Zonal Water cut (%)
2168,5-2169,5	1	0	0	0	0
2175,0-2179,0	4	77	77	0	0
2181,5-2184,0	2,5	42	42	0	0
2205,0-2214,5	9,5	4976	4976	0	0

IN Situ Rate 3 — Flowing pressure at 2170 m = 2396,95 psia

Depths of interval (m)	interval length (m)	Zonal gross prod. m3/d	Zonal Free Gas Prod. m3/d	Zonal water prod. m3/d	Zonal Water cut (%)
2168,5-2169,5	1	0	0	0	0
2175,0-2179,0	4	234	234	0	0
2181,5-2184,0	2,5	164	164	0	0
2205,0-2214,5	9,5	6452	6452	6	6

IN Situ Rate 4 — Flowing pressure at 2170 m = 2321,55 psia

Depths of interval (m)	interval length (m)	Zonal gross prod. m3/d	Zonal Free Gas Prod. m3/d	Zonal water prod. m3/d	Zonal Water cut (%)
2168,5-2169,5	1	0	0	0	0
2175,0-2179,0	4	613	613	0	0
2181,5-2184,0	2,5	94	94	0	0
2205,0-2214,5	9,5	6902	6902	7	7

Tab.1

Case	Tubing Pres. Upper Valve (kg/cm2)	Res A Prod e6 m3/d	Tubing Pres. Res A (kg/cm2)	Res C Prod e6 m3/d	Tubing Pres. Res C (kg/cm2)	Total Well Prod e6 m3/d
Base Case 7" Tubing Commingled	130.9	0.277		2.161		2.438
SmartWell Case 7" Tubing 3.5" Tailpipe	125.9	0.29		1.922		2.212
SmartWell Case 5.5" Tubing 3.5" Tailpipe	142.0	0.226		1.635		1.861
SmartWell Case 4.5" Tubing 3.5" Tailpipe	158.9	0.113		1.203		1.316
SmartWell Case 7" Tubing 4.5" Tailpipe	128.4	0.283		2.077		2.360
SmartWell Case 5.5" Tubing 4.5" Tailpipe	144.8	0.214		1.731		1.945
SmartWell Case 4.5" Tubing 4.5" Tailpipe	161.0	0.098		1.249		1.347
Dual Completion 3.5" C x 3.5" A		0.3	124.5	0.716	173.6	1.016
Dual Completion 4.5" C x 2.875" A		0.256	136.6	1.272	163.4	1.528

Tab.2

Case	Tubing Pres. Upper Valve (bar)	Res A Prod e6 m3/d	Tubing Pres. Res A (bar)	Res C Prod e6 m3/d	Tubing Pres. Res C (bar)	Total Well Prod e6 m3/d
Base Case 7" Tubing Commingled	164.64	0.361		1.547		1.908
SmartWell Case 7" Tubing 3.5" Tailpipe	159.98	0.557		0.983		1.540
SmartWell Case 5.5" Tubing 3.5" Tailpipe	162.99	0.352		0.752		1.104
SmartWell Case 4.5" Tubing 3.5" Tailpipe	164.14	0.000		0.655		0.655
SmartWell Case 7" Tubing 4.5" Tailpipe	161.6	0.458		1.328		1.786
SmartWell Case 5.5" Tubing 4.5" Tailpipe	164.17	0.208		0.978		1.186
SmartWell Case 4.5" Tubing 4.5" Tailpipe	165.31	- 0.088		0.786		0.698
Dual Completion 3.5" C x 3.5" A		0.299	165.3	0.351	169.5	0.650
Dual Completion 4.5" C x 2.875" A		0.187	166.2	0.706	168.5	0.893

Tab.3

FIGURES

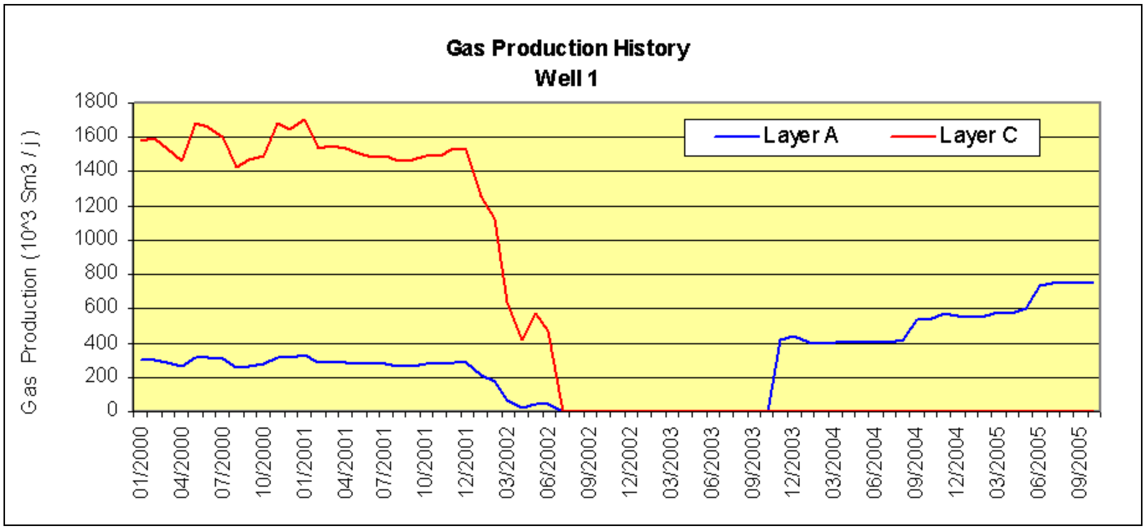


Fig 1

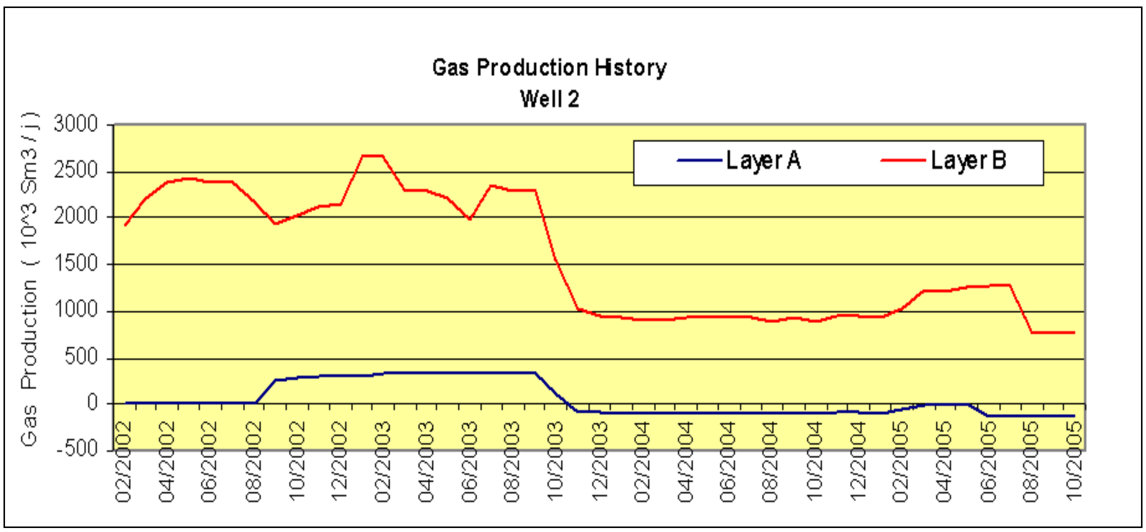


Fig 2

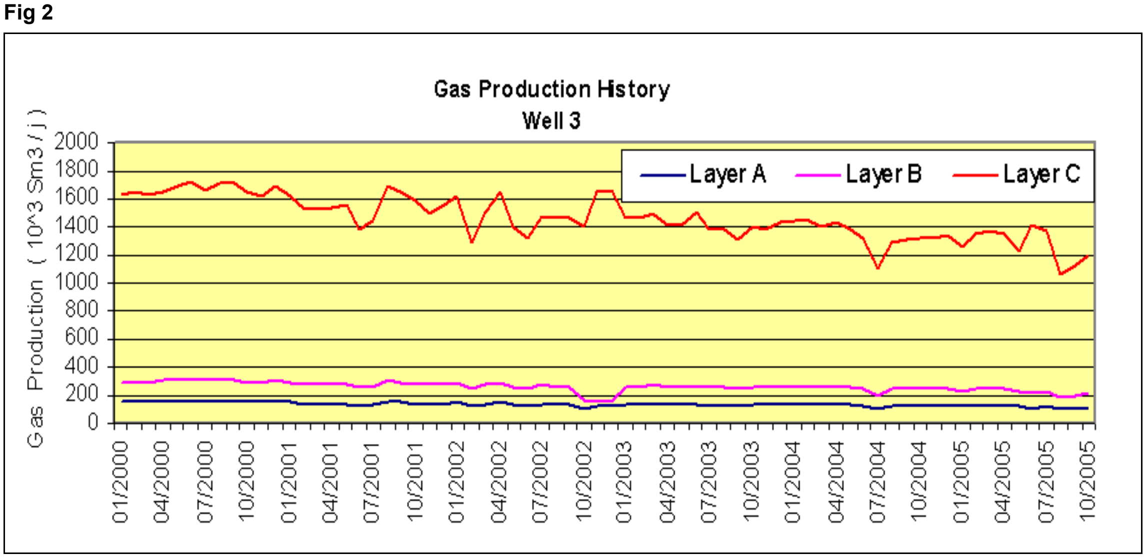
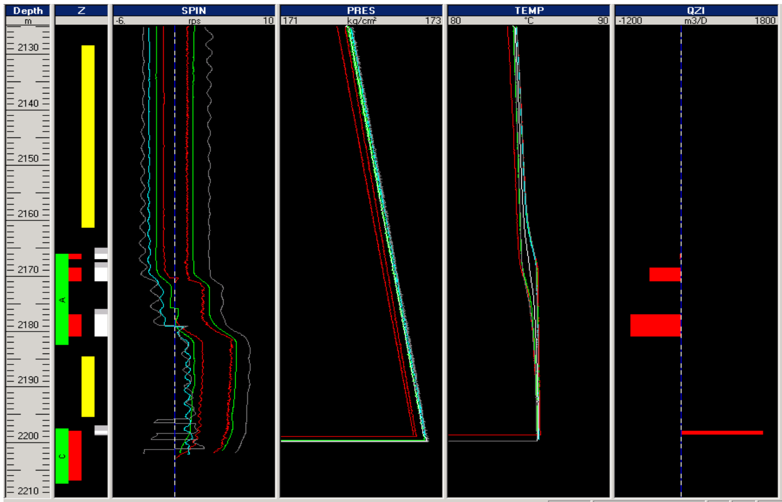
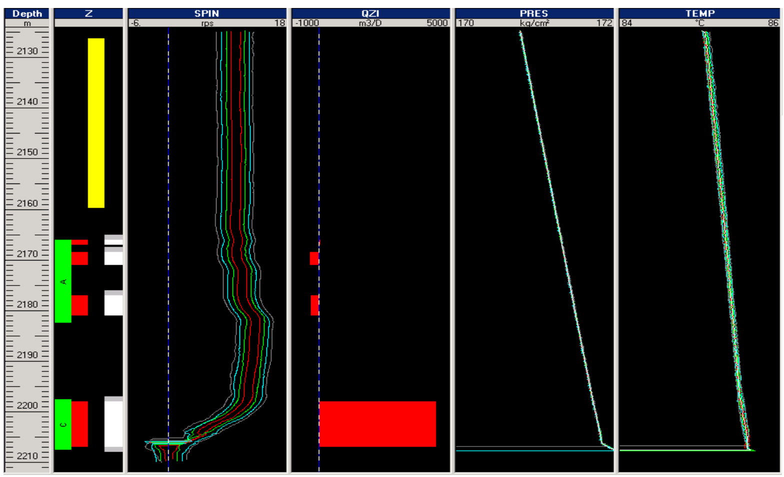


Fig 3



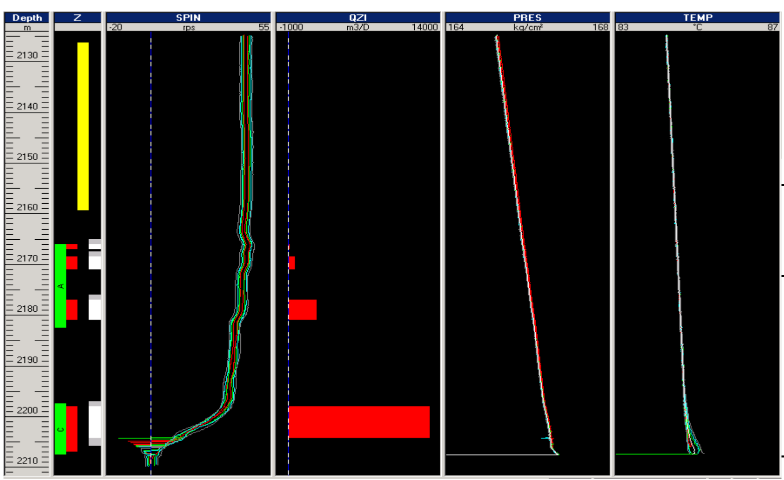
Zones m	Qt res. m3/D	Production %	
2166.0-2167.0	-13.01	-0.43	
2168.5-2171.0	-569.85	-18.80	
2177.0-2181.0	-919.77	-30.34	
2198.0-2198.6	1528.47	50.43	

fig 4 Well 2 shut well



Zones m	Qt res. m3/D	Production %	
2166.0-2167.0	66.84	1.29	
2168.5-2171.0	-329.67	-6.35	
2177.0-2181.0	-312.26	-6.02	
2198.0-2207.0	4479.76	86.34	

Fig 5 Well 2 Rate 1



Zones m	Qt res. m3/D	Production %	
2166.0-2167.0	168.95	1.02	
2168.5-2171.0	641.34	3.88	
2177.0-2181.0	2699.39	16.32	
2198.0-2204.3	13031.30	78.78	

Fig 6 Well 2 Rate 4

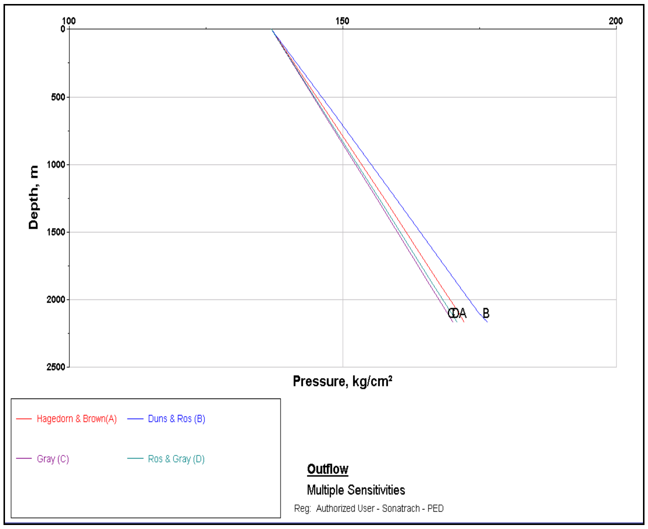


Fig 7 result of correlation , with PLT results Well 1

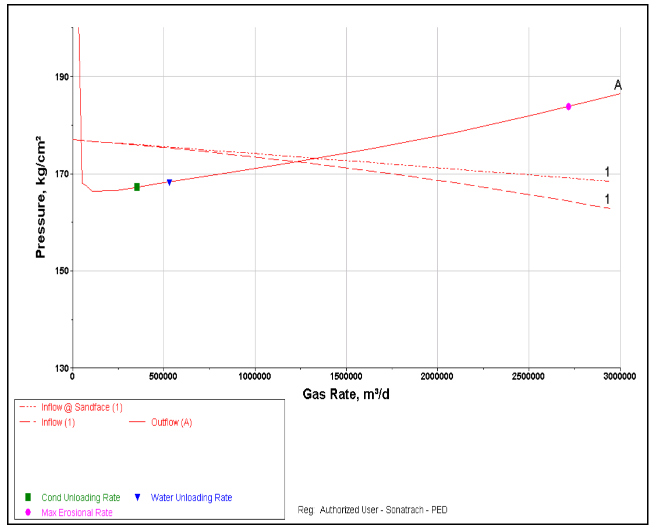


fig 8 Well 1 before lower zone C isolated

SOLUTION POINTS

Solution Point Flow Rates [m³/d]

(A)

(1) 1225184.6

Solution Point Pressures [kg/cm²]

(A)

(1) 172.459

Completion Pressure Drop at Solution Points [kg/cm²]

(A)

(1) 1.020

fig 9 Well 1 before lower zone C isolated

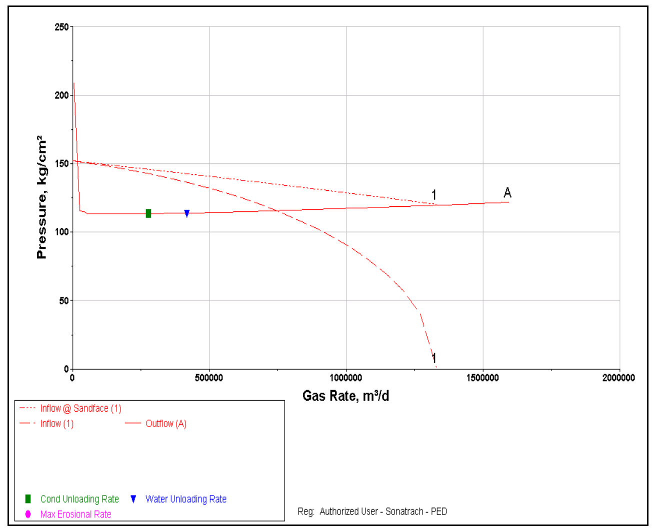


fig 10 results of the actual flow , for this well 1

SOLUTION POINTS

Solution Point Flow Rates [m³/d]

(A)

(1) 745026.4

Solution Point Pressures [kg/cm²]

(A)

(1) 115.506

Completion Pressure Drop at Solution Points [kg/cm²]

(A)

(1) 19.457

fig 11 results of the actual flow , for this well 1

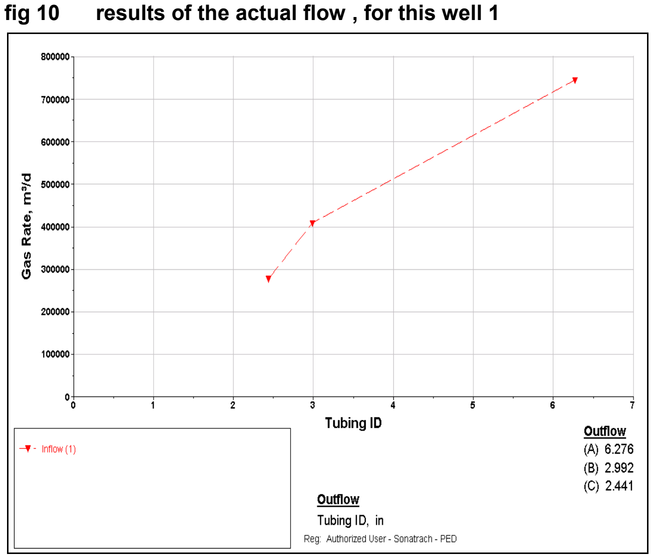


fig 12 dual completion, for the upper zone A Well 1

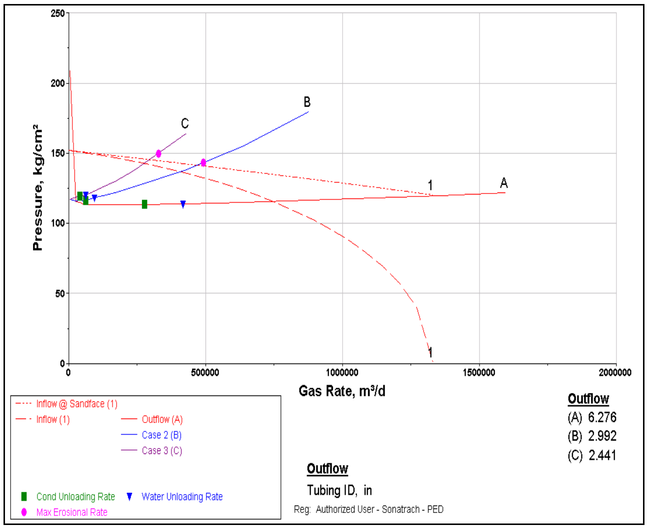


fig 13 dual completion, for the upper zone A Well 1

SOLUTION POINTS

Solution Point Flow Rates [m³/d]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.441
(1)	745026.4	408725.7	277240.1

Solution Point Pressures [kg/cm²]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.441
(1)	115.506	136.746	142.720

Completion Pressure Drop at Solution Points [kg/cm²]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.441
(1)	19.457	6.081	3.100

fig 14 results dual completion, upper zone A well 1

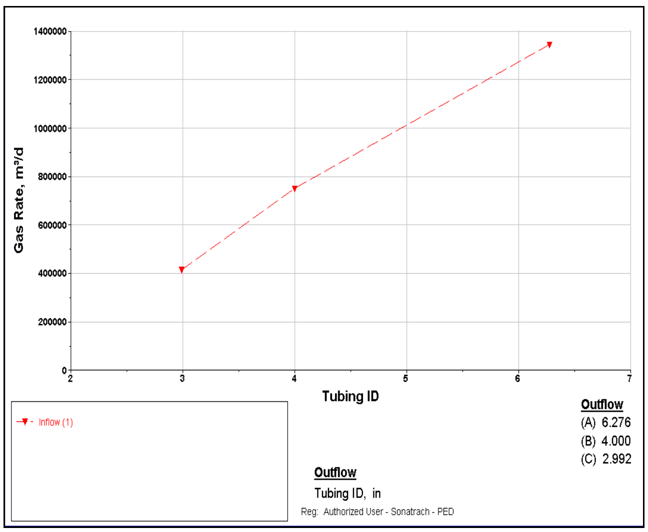


fig 15 dual completion, for the lower zone C Well 1

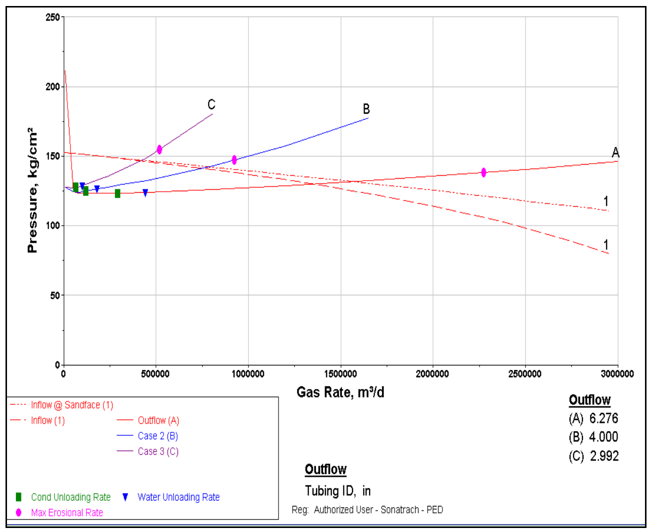


Fig 16 dual completion, for the lower zone C Well 1

SOLUTION POINTS

Solution Point Flow Rates [m³/d]

	(A)	(B)	(C)
(1)	1345625.0	751702.6	414355.1

Solution Point Pressures [kg/cm²]

	(A)	(B)	(C)
(1)	129.887	141.248	146.688

Completion Pressure Drop at Solution Points [kg/cm²]

	(A)	(B)	(C)
(1)	4.774	1.476	0.477

Fig 17 dual completion, for the lower zone C Well 1

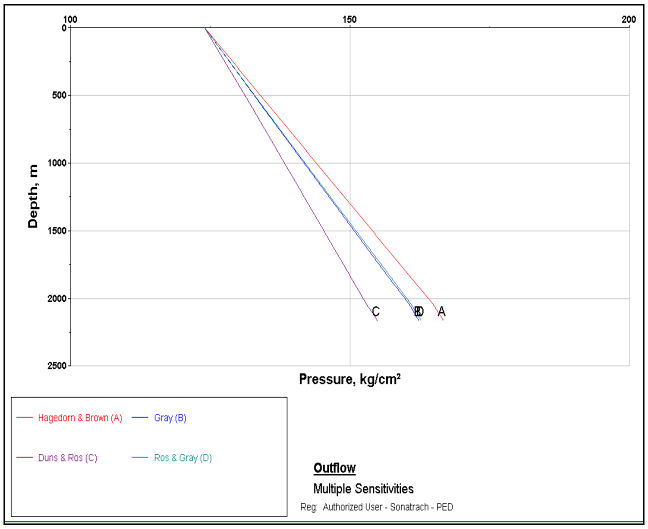


fig 18 result of correlation , with PLT results Well 2

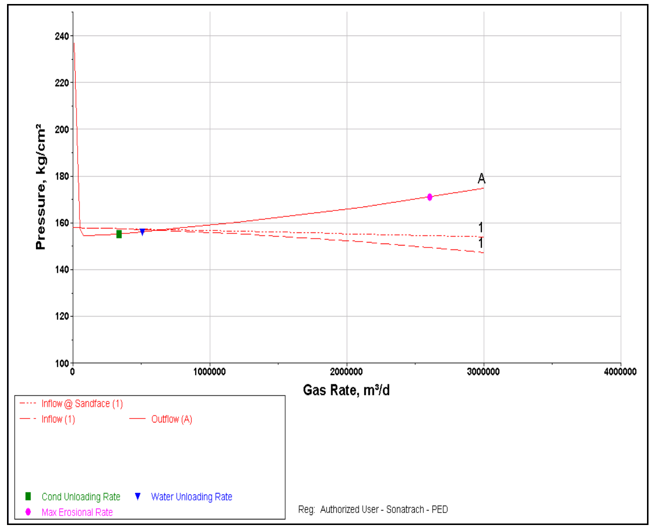


Fig 19 results of the actual flow , for this well 2

SOLUTION POINTS

Solution Point **Flow Rates** [m³/d]

	(A)
(1)	620352.2

Solution Point **Pressures** [kg/cm²]

	(A)
(1)	156.840

Completion Pressure Drop at Solution Points [kg/cm²]

	(A)
(1)	0.344

fig 20 results of the actual flow , for this well 2

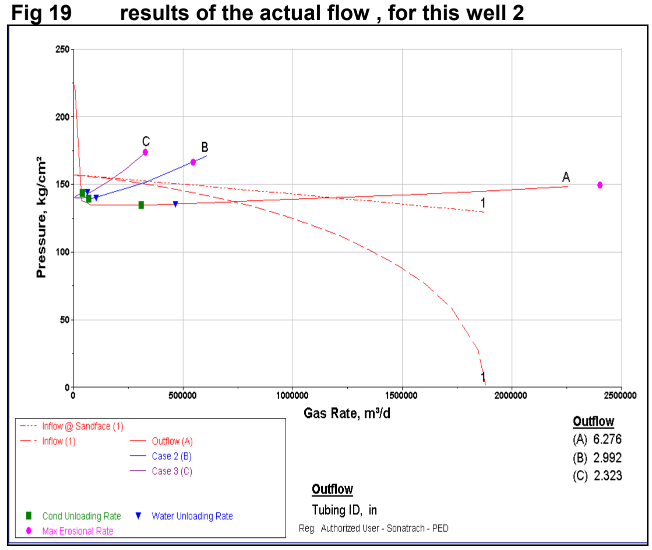


Fig 21 dual completion, for the upper zone A Well 2

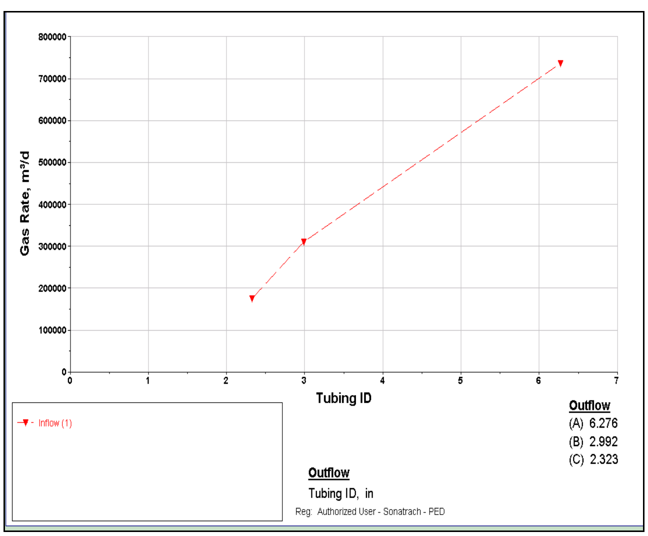


fig 22 dual completion, for the upper zone A Well 2

SOLUTION POINTS

Solution Point **Flow Rates** [m³/d]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.323
(1)	735897.0	311257.0	175623.8

Solution Point **Pressures** [kg/cm²]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.323
(1)	137.091	150.779	153.828

Completion Pressure Drop at Solution Points [kg/cm²]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.323
(1)	9.553	1.897	0.741

Fig 23 dual completion, for the upper zone A Well 2

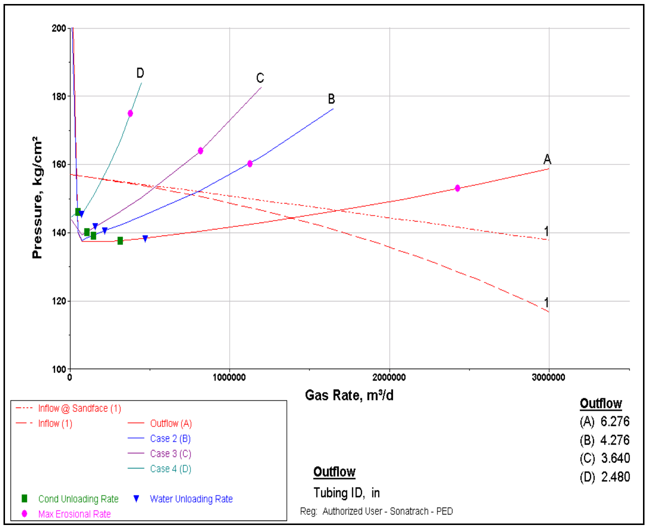


fig 24 dual completion, for the lower zone C Well 2

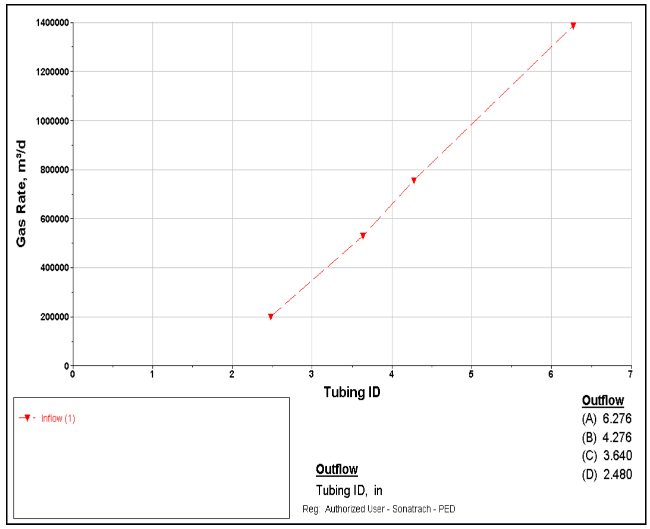


Fig 25 dual completion, for the lower zone C Well 2

SOLUTION POINTS

Solution Point Flow Rates [m³/d]

	Tubing ID [in]			
	(A) 6.276	(B) 4.276	(C) 3.640	(D) 2.480
(1)	1387381.4	757760.0	528410.9	201558.6

Solution Point Pressures [kg/cm²]

	Tubing ID [in]			
	(A) 6.276	(B) 4.276	(C) 3.640	(D) 2.480
(1)	144.272	151.071	153.115	155.641

Completion Pressure Drop at Solution Points [kg/cm²]

	Tubing ID [in]			
	(A) 6.276	(B) 4.276	(C) 3.640	(D) 2.480
(1)	4.053	1.231	0.619	0.118

fig26 dual completion, for the lower zone C Well 2

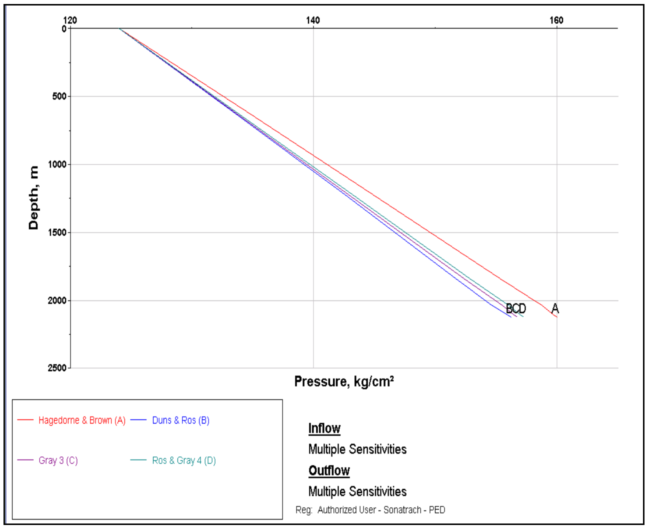


fig 28 result of correlation , with PLT results Well 3

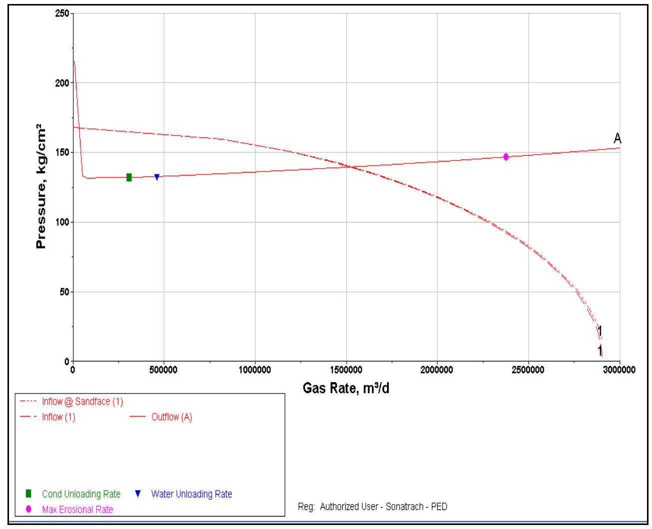


Fig 29 results of the actual flow , for this well 3

SOLUTION POINTS

Solution Point Flow Rates [m³/d]

	(A)
(1)	1524337.2

Solution Point Pressures [kg/cm²]

	(A)
(1)	139.505

Completion Pressure Drop at Solution Points [kg/cm²]

	(A)
(1)	0.236

fig 30 results of the actual flow , for this well 3

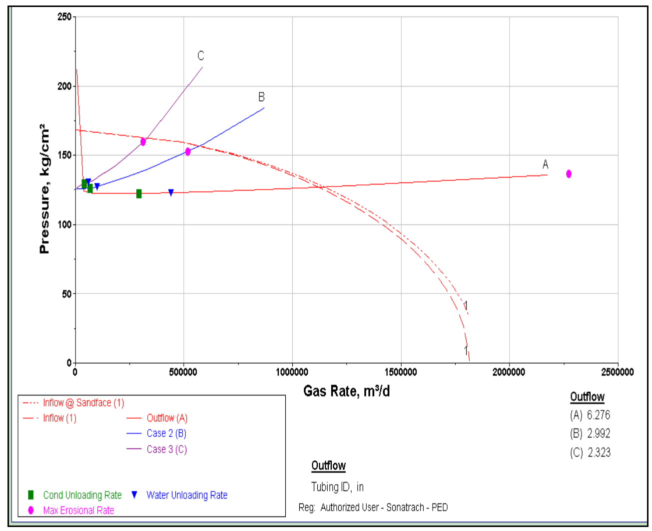


Fig 31 dual completion, for the upper zone A Well 3

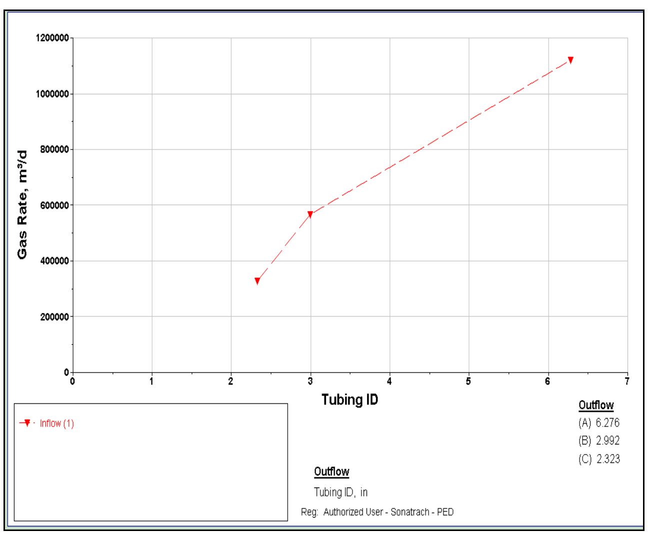


fig 32 dual completion, for the upper zone A Well 3

SOLUTION POINTS

Solution Point Flow Rates [m³/d]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.323
(1)	1119276.6	566987.3	327924.0

Solution Point Pressures [kg/cm²]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.323
(1)	127.076	156.442	162.178

Completion Pressure Drop at Solution Points [kg/cm²]

Tubing ID [in]

	(A) 6.276	(B) 2.992	(C) 2.323
(1)	1.814	0.509	0.262

Fig 33 dual completion, for the upper zone A Well 3

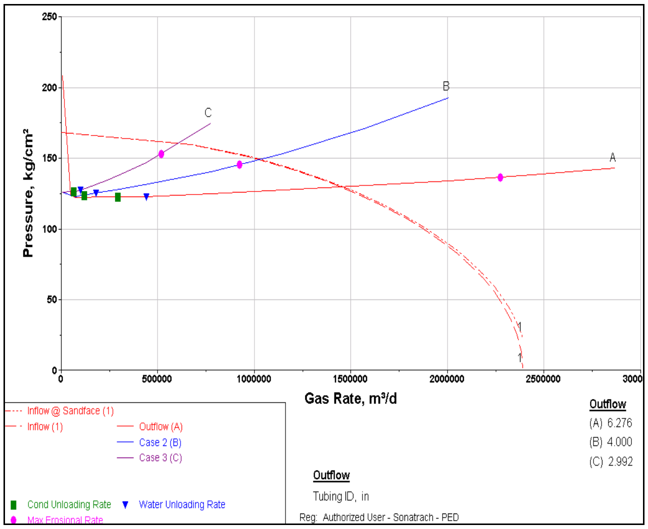


fig 34 dual completion, for the lower zone C Well 3

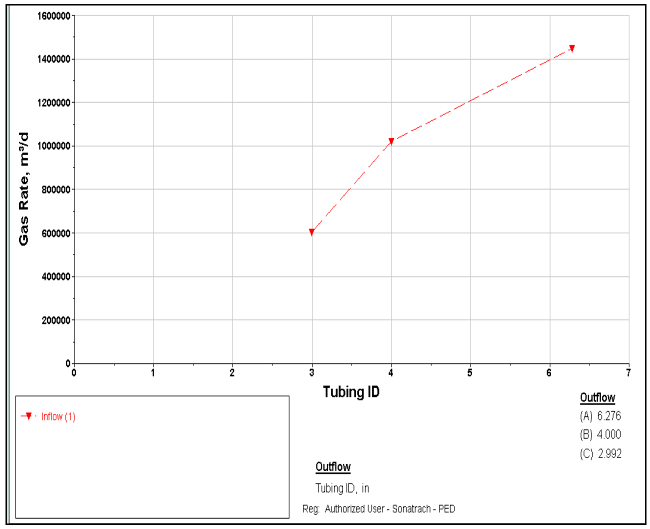


Fig 35 dual completion, for the lower zone C Well 3

SOLUTION POINTS

Solution Point Flow Rates [m³/d]

Tubing ID [in]	(A) 6.276	(B) 4.000	(C) 2.992
(1)	1449410.6	1021857.6	602898.7

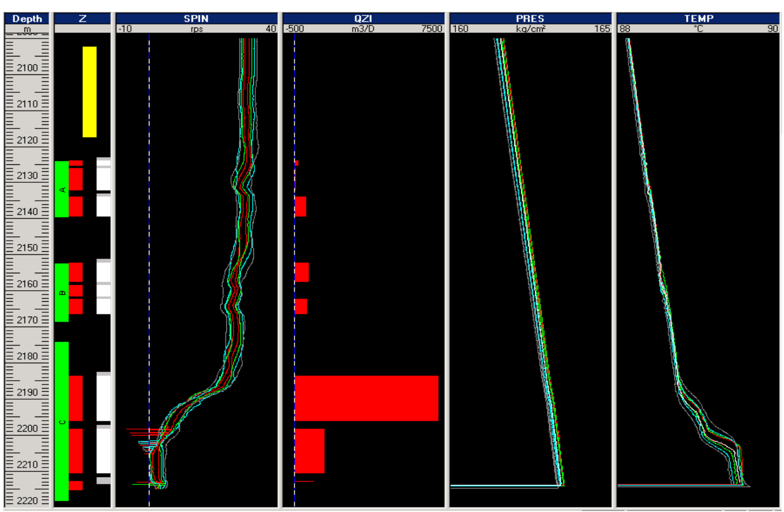
Solution Point Pressures [kg/cm²]

Tubing ID [in]	(A) 6.276	(B) 4.000	(C) 2.992
(1)	129.498	148.891	160.360

Completion Pressure Drop at Solution Points [kg/cm²]

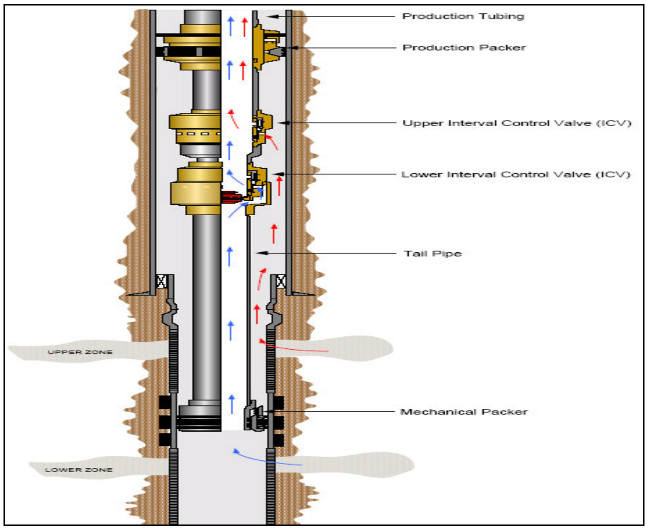
Tubing ID [in]	(A) 6.276	(B) 4.000	(C) 2.992
(1)	0.739	0.347	0.141

Fig 36 dual completion, for the lower zone C Well 3



Zones m	Qt res. m3/D	Production %
2124.0-2125.4	236.92	1.94
2126.0-2132.3	114.48	0.94
2134.0-2139.5	633.01	5.19
2152.3-2157.6	766.09	6.28
2158.4-2161.6	16.76	0.14
2162.4-2166.5	679.01	5.56
2183.6-2196.3	7210.19	59.08
2198.3-2210.8	1545.50	12.66
2212.8-2213.0	1002.59	8.21

Fig 37 Rate 3 Well 3



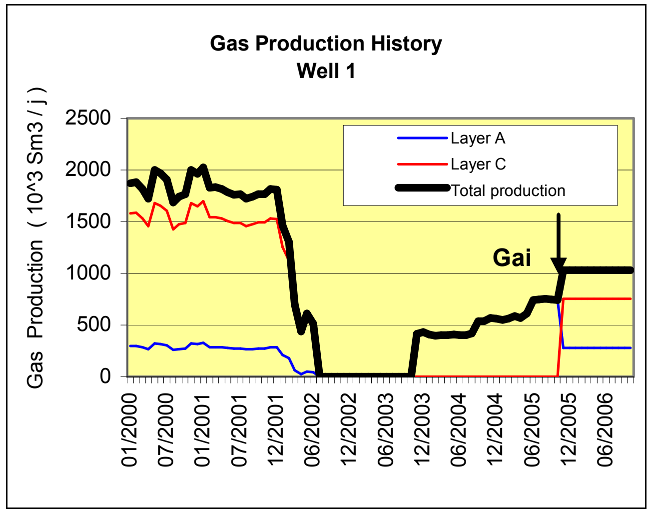


Fig 38 smart well completion

Fig 39 Gain in production Well 1